Harmonizing Open Source test definitions

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Outline

- Differences between test frameworks
- What is the “test definition”
- Element-by-element comparison
  - Between Fuego and Linaro
- Ways to share definitions between Fuego and Linaro

Test Framework differences

- Different test frameworks have different APIs, test models

	Fuego	LAVA	Yocto Project
test driven from	host	target	target
target lifecycle	multiple tests per boot	re-provision for every job	n/a
languages	host: bash, python, yaml, json target: sh	sh, awk, yaml	python
APIs	*X*	*Y*	*Z*
dependencies	permission, kconfig, mem, storage	permission, packages	packages

Factorization

- Different frameworks factor their data and services quite differently.
  - Where operations are performed:
    - 1) central server, 2) on a local host, or 3) on-DUT
  - Which entity is responsible for performing the operation:
    - 1) the test itself, 2) the framework, 3) an external service, or 4) the end user (tester)
  - When are operations performed:
    - 1) during the test, 2) during post-processing, 3) synchronously, 4) asynchronously, etc.
  - Test definition elements are in different files, to support per-test, per-board, or per-lab customizations

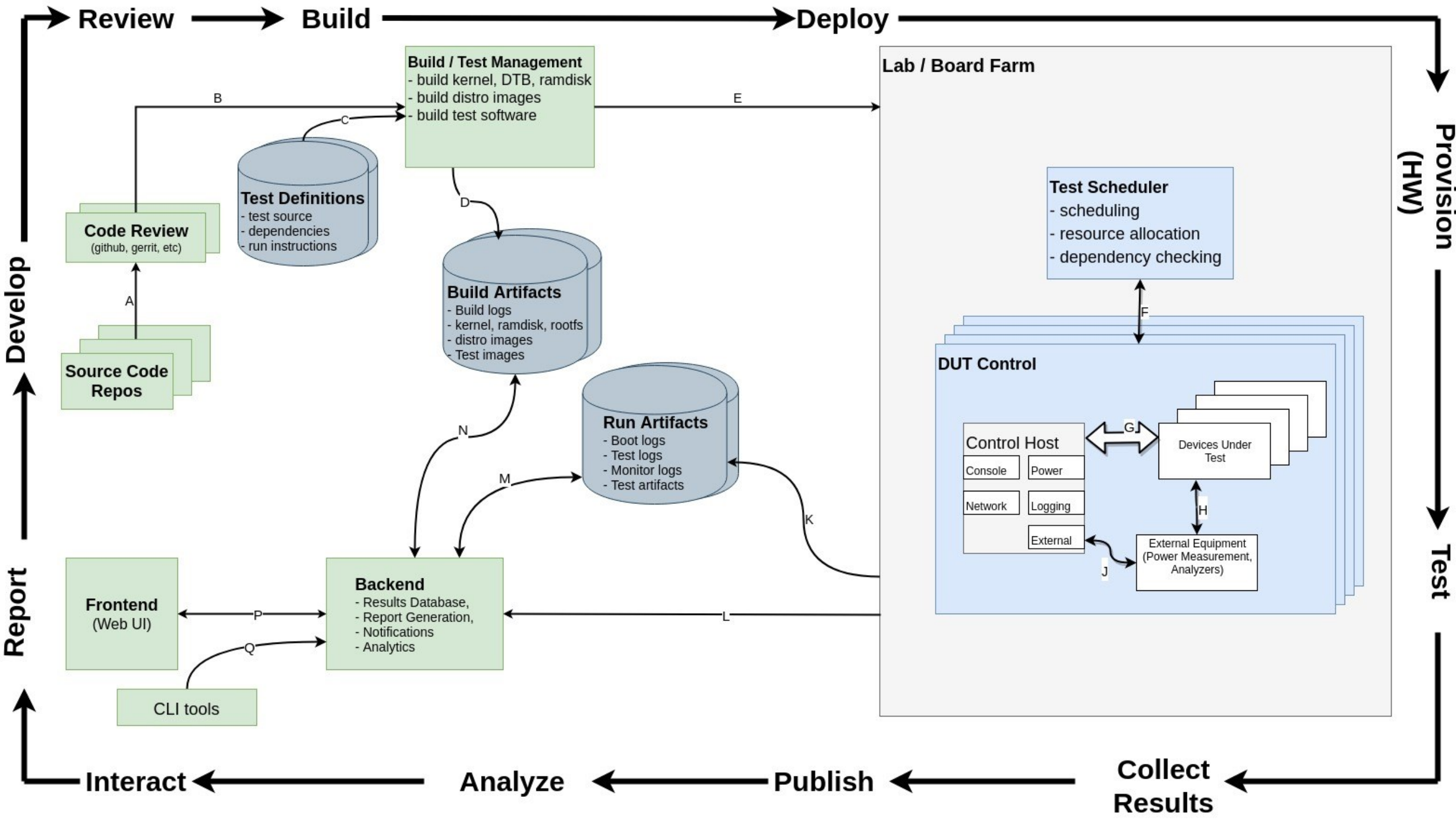
Review
Build
Deploy
Provision (HW)
Test
Collect Results
Publish
Analyze
Interact
Report
Develop
Build / Test Management
- build kernel, DTB, ramdisk
- build distro images
- build test software
Test Definitions
- test source
- dependencies
- run instructions
Code Review
(github, gerrit, etc)
Source Code Repos
Build Artifacts
- Build logs
- kernel, ramdisk, rootfs
- distro images
- Test images
Run Artifacts
- Boot logs
- Test logs
- Monitor logs
- Test artifacts
Lab / Board Farm
Test Scheduler
- scheduling
- resource allocation
- dependency checking
DUT Control
Control Host
Console
Power
Network
Logging
External
Devices Under Test
External Equipment (Power Measurement, Analyzers)
Backend
- Results Database,
- Report Generation,
- Notifications
- Analytics
Frontend
(Web UI)
CLI tools
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q

Diagram key

- Boxes = processes or services
- Cylinders = repositories (persistent storage)
- Lines = APIs

- Lots of systems have implicit APIs or hardcoded values
  - e.g. save a raw file to local filesystem

What is a “Test definition”?

- Meta-data and instructions for a running a test
- Elements:
  - Information about a test
  - Pre-requisites and dependencies
  - Instructions for test execution
  - Output parsing
  - Test variables
  - Results analysis
  - Visualization control

Test definition survey

- Conducted survey in January
  - Results at: https://elinux.org/Test_definition_survey
- Tried to find some “Rosetta Stone” tests
  - That were the same in each system
  - Lots of fields are optional, so no single test revealed all elements
  - sysbench, OpenSSL, iperf

Files comparison

- Fuego
  - test.yaml – meta-data
  - fuego_test.sh – test functions, pre-requisites
  - spec.json – test variable definitions
  - parser.py – parser
  - criteria.json – pass criteria
  - chart_config.json – results formatting
  - <tarfile>.tar.gz – source for test program
- Linaro
  - sysbench.yaml – meta-data, test parameter definitions
  - sysbench.sh – test functions, dependencies, parser

Elements Comparison

- Information about a test (meta-data)
- Pre-requisites and dependencies
- Execution control
- Test variables
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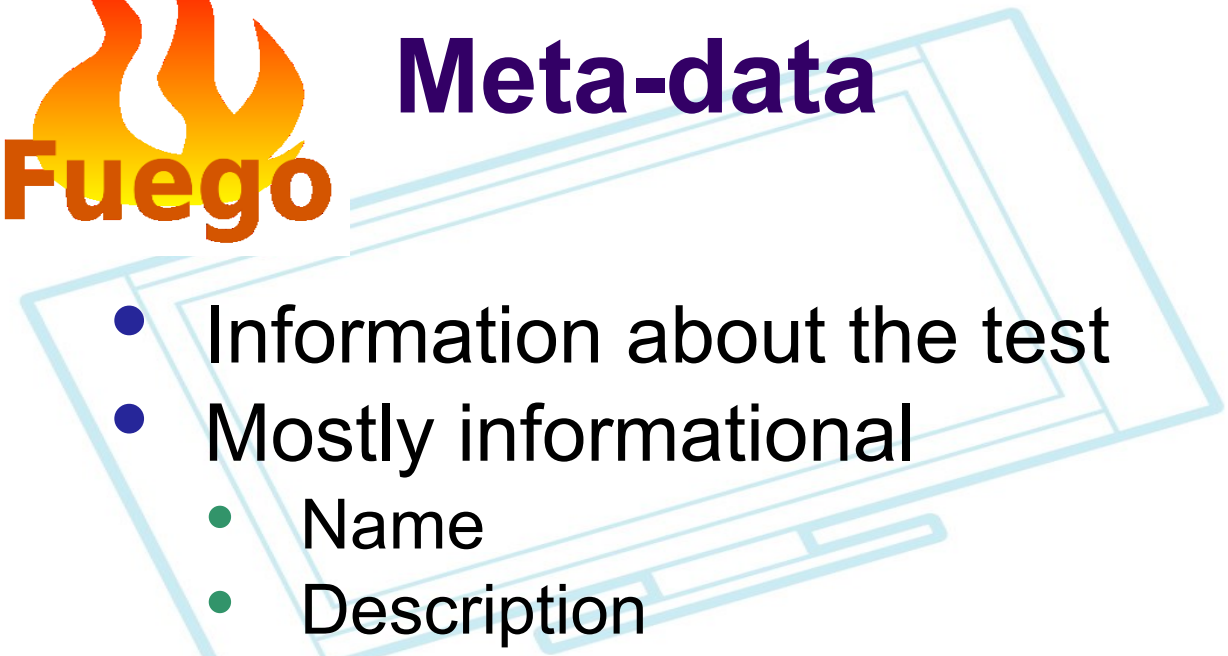
Meta-data

- Information about the test
- Mostly informational
  - Name
  - Description
  - License
- Some functional data
  - Test format version
  - Packaging manifest



Meta-data source

Fuego:

Benchmark.sysbench/test.yaml

```
fuego_package_version: 1
name: Benchmark.sysbench
description: |
    Measure the performance of system operations
    This test only performs the 'cpu' performance test.
    There are other tests available.
license: GPL-2.0
author: Alexy Kopytov
maintainer: Tim Bird <tim.bird@sony.com>
version: 0.4.8
fuego_release: 1
type: Benchmark
tags: ['system', 'cpu', 'performance']
gitrepo: https://github.com/akopytov/sysbench
data_files:
    - fuego_test.sh
    - parser.py
    - spec.json
    - test.yaml
    - sysbench-0.4.8.tar.bz2
    - disable_libtool.patch
    - malloc_cross_compile_fix.patch
```

Linaro:

sysbench.yaml

```
metadata:
    name: sysbench
    format: "Lava-Test-Shell Test Definition 1.0"
    description: "SysBench is a modular, cross-platform and multi-threaded
                  benchmark tool for evaluating OS parameters that are
                  important for a system running a database under intensive
                  load. Current features allow to test fileio, cpu, memory,
                  threads, mutex and oltp."
    maintainer:
        - chase.qi@linaro.org
    os:
        [ ‘debian’, ‘Ubuntu’, ‘fedora’, ‘centos’, ‘openembedded’ ]
    scope:
        - performance
    environment:
        - lava-test-shell
    devices:
        [ ‘hi6220-hikey’, ‘apq8016-sbc’, ‘mustang’, ‘moonshot’, ‘thunder’, ‘d03’, ‘d05’ ]
params: [omitted]
run:
    steps:
        - cd ./automated/linux/sysbench/
        - ./sysbench.sh -n "${NUM_THREADS}" -t "${TESTS}" -s "${SKIP_INSTALL}"
        - ../../utils/send-to-lava.sh ./output/result.txt
```

Meta-data Comparison Table

test.yaml	ex. value	<test>.yaml	ex. value	Meaning
fuego_package_version	1	metadata:format	Lava-Test-Shell Test Definition 1.0	format indicator
name	Benchmark.sysbench	metadata:name	sysbench	
description		metadata:description		human description of test
license/author/version		-	-	test info details
maintainer		metadata:maintainer		person in charge of this test definition
fuego_version	1	metadata:version		release number for this definition
type/tags		scope	performance	for test classification
-	-	os, devices		
params	NTHREADS	params	NTHREADS	test variables
gitrepo		-	-	location of source
data_files		-	-	manifest for test package
(elsewhere)		run:steps		test instructions

Elements Comparison

- Information about a test (meta-data)
- Pre-requisites and dependencies
- Execution control
- Test variables
- Instructions for test execution
- Output parsing or conversion
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Pre-requisites

- Pre-conditions or state required for a test to execute
  - That cannot be changed
  - Something that prevents a test from executing at all
- Some examples:
  - Required kernel versions, kernel configuration
  - Required permissions (root, capabilities)
  - Required programs and libraries
  - Required capacity (e.g minimum memory, processors, storage)
  - Required hardware (net device, bus, etc.)
    - Usually use kernel config as a proxy for this
  - Arbitrary system attribute (logging system, init system, distro)
- Confusing: Fuego calls this a dependency.

Pre-requisites

Fuego:fuego_test.sh

- Need variables:
  - NEED_MEMORY
  - NEED_FREE_STORAGE
  - NEED_KCONFIG
  - NEED_ROOT
  - NEED_PROGRAM
- Pre_check functions:
  - assert_define
  - is_on_target
  - is_on_sdk
  - assert_has_program

Linaro: <testname>.yaml, <testname>.sh

- os
- devices
- functions:
  - check_root
- packages
  - saw this in one script:

```
pkgs="git make docker"
for i in ${pkgs}; do
   if ! command -v "$i"; then
        error_msg "$i is required but not installed!"
   fi
done
```

- device tags?

Pre-requisites source

Fuego:

Functional.openct/fuego_test.sh

```
function test_pre_check {
    assert_has_program openct-control
    assert_has_program openct-tool
}
```

Benchmark.hackbench/fuego_test.sh

```
NEED_ROOT=1

function test_pre_check {
    assert_define BENCHMARK_HACKBENCH_PARAMS
}
```

Linaro:

sysbench.sh

```
! check_root && error_msg "Please run this script as root."
```

Dependencies

- Things to install in order to execute the program
  - packages, libraries, programs
- Fuego:
  - There's no system support for this
  - But can put files from test_deploy(), and install during test_run()
    - No known instances of this
- Linaro:
  - install_deps – for installing required packages

Elements Comparison

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Test execution control

- Controls where and when and how long a test can execute
- Fuego:
  - Labels used to restrict job to a specific node (or node class)
  - Triggers left as an exercise for the user
    - Triggers defined by end user in Jenkins job
  - Timeouts come from testplans
- Linaro:
  - Test definition indicates acceptable target OS, device
  - Job definition indicates acceptable device tag?
  - Timeouts come from job definition?

Elements Comparison

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Test variables

- Test variables = parameters that can be modified to customize a test
- Fuego:
  - Described in test.yaml file
  - Defined in spec.json, or on ftc command line (dynamic variables)
  - Utilized in fuego_test.sh function test_run()
- Linaro:
  - Defined in <test>.yaml file, or in job or command line?
  - Utilized in run:steps, and in <test>.sh file
    - Seems common to parse them from <test>.sh command line

Test variables source

Fuego:

Benchmark.iperf3/test.yaml

```
params:
    - server_ip:
        description: |
            IP address of the server machine.
        example: 192.168.1.45
        optional: yes
    - client_params:
        description: extra parameters for the client
        example: -p 5223 -u -b 10G
        optional: yes
```

Benchmark.iperf3/spec.json

```
{
    "testName": "Benchmark.iperf3",
    "specs": {
        "default": { "client_params": "-O 4 -t 64“ },
        "zerocopy": { "client_params": "-O 4 -t 64 -Z“ },
        "udp": { "client_params": "-t 60 -u -b 400M“ }
    }
}
```

Linaro:

sysbench.yaml

```
params:
    # "${TESTS}" could be one or more of the following tests.
    # TESTS: cpu memory threads mutex fileio oltp
    # TESTS: "oltp"
    TESTS: "percpu cpu memory threads mutex fileio"
    # Number of threads to run.
    # Run $(nproc) threads by default.
    NUM_THREADS: "NPROC"
    SKIP_INSTALL: "false"
```

Elements Comparison

- Information about a test (meta-data)
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Test instructions

- Actual commands to execute on the device under test
- Fuego:
  - Instructions are in fuego_test.sh:test_run() function (but this runs on the host)
    - Uses ‘report’ to execute a command on a board and save output to log
- Linaro:
  - Instructions are in <test>.yaml:run:steps
  - And in <test>.sh, which runs on the device under test

Test Instructions

- Fuego: fuego_test.sh shell functions
  - test_pre_check()
  - test_build()
  - test_deploy()
  - test_run()
  - test_processing()
  - Fuego divides test operations into pre-defined phases
- Linaro:
  - <test>.yaml:run:steps
  - <test>.sh

Test instructions source

Fuego:

Functional.hello_world/fuego_test.sh

```
tarball=hello-test-1.0.tgz
function test_build {
    make
}
function test_deploy {
    put hello  $BOARD_TESTDIR/fuego.$TESTDIR/
}
function test_run {
    report "cd $BOARD_TESTDIR/fuego.$TESTDIR;  \
        ./hello $FUNCTIONAL_HELLO_WORLD_ARG"
}
function test_processing {
    log_compare "$TESTDIR" "1" "SUCCESS" "p"
}
```

Linaro:

sysbench.yaml

```
run:
    steps:
        - cd ./automated/linux/sysbench/
        - ./sysbench.sh -n "${NUM_THREADS}" -t "${TESTS}“ \
              -s "${SKIP_INSTALL}"
        - ../../utils/send-to-lava.sh ./output/result.txt
```

sysbench.sh

```
#!/bin/sh -e
. ../../lib/sh-test-lib

OUTPUT="$(pwd)/output"
RESULT_FILE="${OUTPUT}/result.txt"
...
install_sysbench() ...
general_parser() ...
for tc in ${TESTS}; do
...
        sysbench --num-threads="${NUM_THREADS}"  \
            --test="${tc}" run | tee "${logfile}".
...
```

Build instructions source

Fuego:

Benchmark.sysbench/fuego_test.sh

```
tarball=sysbench-0.4.8.tar.bz2

function test_build {
    patch -p0 < $TEST_HOME/malloc_cross_compile_fix.patch
    patch -p0 < $TEST_HOME/disable_libtool.patch
    ./autogen.sh

     cp /usr/share/misc/config.{sub,guess} config
    ./configure --host=$PREFIX --without-mysql
    make
}
```

Linaro:

sysbench.sh

```
install_sysbench() {
    git clone https://github.com/akopytov/sysbench
    cd sysbench
    git checkout 0.4
    ./autogen.sh
    if echo "${TESTS}" | grep "oltp"; then
        ./configure
    else
        ./configure --without-mysql
    fi
    make install
    cd ../
}
```

Test instructions (and other stuff) Comparison Table

Fuego	Notes	Linaro	Notes
test_pre_check		check_root	
test_build	tarball or git repo, cross-build on host	install_sysbench	git clone, build on target
.		install_sysbench	install required packages
test_deploy	put	install_sysbench	make install
test_run		run:steps/sysbench.sh	
parser.py	python parsing	general_parser	sh, sed, awk
test.yaml:params	describe parameter vars	-	
spec.json	define parameter values	<test>.yaml:params	define parameter values
test.yaml:data_files	manifest for packaging	-	
criteria.json	results analysis	-	

Elements Comparison

- Information about a test (meta-data)
- Pre-requisites and dependencies
- Execution control
- Test variables
- Instructions for test execution
- Output parsing or conversion
- Results analysis
- Visualization control

Parsing

- Parsing is:
  - Extracting testcase and measurement results from test output
- Fuego:
  - Performed by parser.py, using a library of helper functions
  - Also, data points are converted to a common format (run.json)
  - Also, charting data (html tables and plots) are prepared
- Linaro:
  - Performed by <test>.sh (to get to data points)
    - data points converted to LAVA-parsable strings in console output
  - ?? – converts data points into common format
  - ?? – converts common format into charts

Fuego: Parsing source

Benchmark.sysbench/parser.py

```
import os, re, sys
measurements = {}
regex_string = "^.*total time:\s+([\d]{1,8}.?[\d]{1,43})s$"
matches = plib.parse_log(regex_string)
if matches:
    measurements['cpu.prime_calculation'] = [{"name": "time", "measure" : float(matches[0])}]
regex_string = "^.*events \(avg/stddev\):\s+([\d]{1,8}.?[\d]{1,43})/.*$"
matches = plib.parse_log(regex_string)
if matches:
    measurements['cpu.thread_fairness'] = [{"name": "events", "measure" : float(matches[0])}]
sys.exit(plib.process(measurements))
```

Linaro:

sysbench.sh

```
general_parser() {
    # if $1 is there, let's append to test name in the result file
    local tc="$tc$1"
    ms=$(grep -m 1 "total time" "${logfile}" | awk '{print substr($NF,1,length($NF)-1)}')
    add_metric "${tc}-total-time" "pass" "${ms}" "s"
    ms=$(grep "total number of events" "${logfile}" | awk '{print $NF}')
    add_metric "${tc}-total-number-of-events" "pass" "${ms}" "times"
    ...
    ms=$(grep "execution time (avg/stddev)" "${logfile}" |  awk '{print $NF}')
    ms_avg=$(echo "${ms}" | awk -F'/' '{print $1}')
    ms_stddev=$(echo "${ms}" | awk -F'/' '{print $2}')
    add_metric "${tc}-execution-time-avg" "pass" "${ms_avg}" "s"
    add_metric "${tc}-execution-time-stddev" "pass" "${ms_stddev}" "s"
}
```

Parsing

- Location and factoring are different:
- Location:
  - Fuego does all parsing on the host
  - Linaro does testcase and measurement conversion to a common format, on the target
  - Linaro does conversion to common format on ??? (where?)
- Factoring:
  - Fuego does extraction, conversion to common format, chart preparation in one step
  - Linaro does some of these operations elsewhere

Parsing notes

- Linaro deprecated their “parse pattern and fixup dictionaries”, with the following quote:
  - “Parse patterns and fixup dictionaries are confusing and hard to debug.”
    - source: https://lkft.validation.linaro.org/static/docs/v2/lava_test_shell.html

Elements Comparison

- Information about a test (meta-data)
- Pre-requisites and dependencies
- Execution control
- Test variables
- Instructions for test execution
- Output parsing or conversion
- Results analysis *(skipping these)*
- Visualization control

Linaro things with no Fuego analog

- Package dependencies
- os
- devices
- Multi-node tests
  - Every Fuego test is implicitly multi-node with the host as the other node

Fuego things with no Linaro analog

- Results analysis - Pass criteria
- Visualization control - Chart config
- Test package
- Target package

Results Analysis

- Describes the requirements (pass counts, fail counts, fail-ok-lists, benchmark value thresholds) for test to pass
  - Used for automated test interpretation
  - This determines the ultimate ‘red or green’ result
  - List of expected failures, or results that are ignored for now
- In criteria.json file
- Able to customize per board, or by some other attribute
- Example: LTP
  - raspberry pi has 28 failures
  - beagleone black has 67 failures, 2 hangs, and 1 kernel panic
    - (kernel panic and hangs testcases are potential skiplist items)

Visualization control

- Control over results output selection and formatting
  - Indicate table or plot
  - Select data points for output
- In chart_config.json file
- (Planned) report templates

Test package

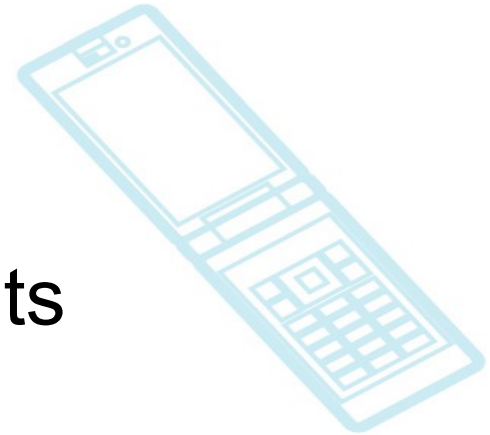
- Package of test materials for sharing with others
  - Consists of metadata, source, instructions, parser, etc.
- Can be sent to a central server, for dispatch to another lab
- *Central server feature is not finished yet*

Target package

- Package of binary materials to be installed on a board
  - pre-built binaries, board-side scripts
  - Result of ‘deploy’ operation
- May correspond to an ‘image’
  - Is not the Software Under Test
- *Central server feature is not finished yet*

Ideas for harmony

- Migrate our test definitions to use same elements
- Run Fuego tests in LAVA
- Run Linaro tests in Fuego
- Co-develop APIs for lab hardware



Migrate test definitions

- Migrate our test definitions to use same elements
- Use same pre-requisite and dependency names
- Use common test variable names and values
- Regularize the test phases in Linaro scripts
- Create a common library for shared features
  - Fuego core function library, and fuego_board_function_lib.sh
  - Linaro sh-test-lib

Run Fuego tests in LAVA

- Old method:
  - Get ssh connection to board from LAVA
  - Have Fuego do it's thing over ssh
  - Doesn't integrate with LAVA scheduler or results processing
- New plan:
  - Write a converter to run a Fuego test in LAVA
    - Deploy target package to LAVA image server?
    - Requires to execute instructions that normally run on Fuego host on the Device under test
      - Maybe create or port the Fuego core library
      - Maybe just run Fuego CLI??
- Issues:
  - Fuego instructions for host are allowed to use bash-isms

Run Linaro tests in Fuego

- Already have a prototype:
  - Functional.linaro
  - Uses test-runner to send a job to LAVA
- Issues:
  - ???

Co-develop APIs for lab hardware

- Start with pdudaemon for PDU control
- Develop consistent APIs for other board control functions:
  - pressing buttons/flipping jumpers
  - bus control (ex dropping vbus to USB)
  - audio collection
  - video collection
  - power monitoring

Harmonization issues

- Factoring of test definition elements
  - Time/location of execution
  - What files has each element
  - Concepts that one system has that the other doesn't
- Required software on target
- Required hardware in lab
- Results format (but that's a whole other topic)
  - But: test definition defines testcase and metric names!
  - Wildly different in Fuego and Linaro, even for the same test

Let’s discuss the details....

Thanks

Tim Bird

Fuego Test System Maintainer

Sr. Staff Software Engineer, Sony Electronics